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ABSTRACT

An overview is given of the potential contribution of computerized information services to communities involved with common disciplines or common missions. The author first describes the knowledge workshop--an environment in which knowledge workers do their knowledge work--and then discusses the prototype of the community workshop which has been supported by the Augmentation Research Center at Stanford Research Institute. Among the significant topics included within the scope of the discussion are: 1) collaborative dialogue, 2) document development, production and control, 3) research intelligence, 4) community handbook development, 5) computer-based instruction, 6) meetings and conferences, 7) community management and organization, and 8) special knowledge work by individuals and teams. A set of conclusions comprises the final section of the paper. (PB)

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COORDINATED INFORMATION SERVICES

for a

DISCIPLINE- OR MISSION-ORIENTED COMMUNITY

by

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TWO-LEVEL, ONE-LINE, CONTENT VIEW

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Generally, adoption of a multi-access computer network is promoted on the basis of increased accessibility and economy 1a
In particular, the *Knowledge Workshop* services described below will grow to become very important to 1b

THE KNOWLEDGE WORKSHOP 2

In using the term *knowledge workshop*, I build directly upon terms *knowledge work* and *knowledge worker*, whose 2a
The knowledge workshop is the specially provided environment in which knowledge workers do their knowledge work. 2b
Basic workshop functions must serve the daily handling of the users' working information -- of their notes, things-to-do 2c
For the past ten years in the Augmentation Research Center (ARC), at Stanford Research Institute, we have 2d
Our focus all along has been toward supporting R&D workers, and we have followed the empirical, bootstrapping 2e
Besides giving constant, pragmatic attention to the needs and possibilities for evolution of support functions and 2f
Technology has reached a state warranting much more activity explicitly applied toward the evolution both of better 2g

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We aren't ignoring exploratory use within localized organizations, but we are committing a substantial portion of our 3a
Following is a brief description of community-Workshop applications that special communities can consider exploring. 3b

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But also, with the probable increase in the amount and intensity of distributed collaboration within the Community, 10a

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INTRODUCTION 1

Generally, adoption of a multi-access computer network is promoted on the basis of increased accessibility and economy of computational and data-bank resources for a distributed community of users. But visualize this resource-sharing computer network as a general-purpose digital-packet transportation system linking resources, processors, vendors, brokers, customers, etc.; then consider that the existence of such a transportation system will inevitably stimulate growth of an information market involving many processes, products, and services. A distributed community availing itself of such a transportation system should rightfully count on such market development for much of its payoff from its early investment. 1a

In particular, the *Knowledge Workshop* services described below will grow to become very important to network-coupled communities that are involved with a common discipline or mission -- my judgement is that this use of computer networks will come to dominate over the purely computational use in scale and generally perceived social worth, with today's type of computer services being seen as but a special subset of the tools integrated into a coherent knowledge workshop. 1b

THE KNOWLEDGE WORKSHOP 2

In using the term *knowledge workshop*, I build directly upon terms *knowledge work* and *knowledge worker*, whose special use I first came across in reading Peter Drucker (Reference 1). He develops a much larger theme about these concepts in Reference 2, adding terms such as *knowledge technologies*, *knowledge economy*, and *knowledge society*, and pointing out that the growing level and importance of knowledge-work activity in our society will produce a discontinuity in our cultural evolution of a scale commensurate with that of the industrial revolution. 2a

The knowledge workshop is the specially provided environment in which knowledge workers do their knowledge work. We can talk about a small knowledge workshop for an individual, or a large knowledge workshop for an organization. Knowledge workshops have existed for centuries, but here we consider maximizing their effectiveness by systematically evolving tools, methods, etc., with heavy dependence upon the new technologies of computer time sharing and networking. (In the text below, read *knowledge workshop* for *Workshop*.) 2b

Basic workshop functions must serve the daily handling of the users' working information -- of their notes, things-to-do lists, memos, letters, designs, plans, budgets, announcements, commentary, proposals, reports, programs, documentation, item-control catalogs, etc. And before it can sensibly be of much value, we believe that a Workshop has to provide for the grubby cut-and-try detail involved in the minute-by-minute, day-after-day worker's handling of this information: in its composition, studying, commenting upon, arguing about, modifying, communicating, publishing, presenting, etc. There are many exciting, elegant tools in the offing -- superlative graphics, artificial-intelligence services, etc. -- but their serious application will only be sensible within an integrated Workshop, and in a manner whose associated conceptual and procedural skills are consistent with those of tools and techniques that support the basic Workshop functions. 2c

For the past ten years in the Augmentation Research Center (ARC), at Stanford Research Institute, we have concentrated in succession on exploring the computer augmentation of knowledge workshops, first for an individual, then as extended for a project team, and then for a network-coupled, distributed community (See Reference 3). Over the past three years we have developed a beginning set of prototype *community-Workshop* services on the ARPANET, as associated with our serving as the Network Information Center (NIC).* 2d

*The following agencies have contributed components of direct support to this ten-year development: The Information Processing Techniques Office (ARPA), Langley Research Center (NASA), Rome Air Development Center (USAF), and the Information Systems Branch (ONR). 2d1

Coordinated Information Services for a Discipline- Or Mission-Oriented Community

Our focus all along has been toward supporting R&D workers, and we have followed the empirical, bootstrapping approach of doing as much of our own work as possible in our Workshop, continuously building, using, and evolving it. Our Workshop services are supplied by a large software system that we call NLS, running under TENEX on a PDP-10. It provides a large repertoire of functions to display terminals (DNLS), online typewriter terminals (TNLS), or via deferred-execution of commands and text from offline typewriters as accumulated on cassettes or other intermediate storage (DEX). Hardcopy output is available on typewriters, online printers, or through an offline phototypesetting device providing publication-grade quality for multi-font text, computer-directed graphic constructs, or scan-stored diagrams. 2e

Besides giving constant, pragmatic attention to the needs and possibilities for evolution of support functions and working methods, we have had to struggle with what is a soul-wrenching burden for people whose orientation is toward exploratory development -- trying to meet the absolutely necessary requirements of organizing, documenting, maintaining, and operating the hardware/software and clerical services towards being responsive and reliable, minute after minute and day after day. 2f

Technology has reached a state warranting much more activity explicitly applied toward the evolution both of better Workshops, and of a coherent discipline associated with Workshop-system development; for this to happen, it is obvious that more people must take on the challenge of becoming *Workshop architects*, and that more pilot-plant Workshops need to be set up for exploratory support of real knowledge-work activities. There are (will be many) approaches to be tried besides ours, of course; but to do our bit toward accellerating this process, we intend to share and extend our developments and knowledge by making our Workshop tools available for exploratory application in distributed, modular, pilot-Workshop sites, and by offering close collaboration with the pilot-Workshop architects. (Note below that an important Workshop feature being offered is designed to facilitate such *distributed collaboration*.) 2g

PROTOTYPE COMMUNITY-WORKSHOP SUPPORT

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We aren't ignoring exploratory use within localized organizations, but we are committing a substantial portion of our energy toward the early, exploratory use of knowledge-workshop services to support distributed, network-coupled communities. There are two special reasons for this commitment: 3a

The first reason concerns relative payoff: if a service facilitates hobnobbing via terminals, there is extra value when this supplants air fare and a two-day trip in contrast with supplanting a walk down the hall; there is more payoff from relatively costly augmentation services when they facilitate collaboration among participants who are distributed rather than among those who are already clustered. 3a1

The second reason concerns a wider awareness of the possibilities for augmenting knowledge workshops, and a wider interest and involvement in their accelerated evolution -- things we hope to enhance by facilitating community-Workshop exploration. We find that toward significant Workshop innovations a user needs a sort of warming-up process before gracefully giving something new a try. Thereafter, in the right environment, he will *naturally* adopt successive stages of significant new Workshop techniques. This process is noticeably facilitated by steady exposure to the products and conventions of Workshop services; and it helps considerably to have a variety of opportunities and materials to stimulate and support the *giving it a try* -- for instance, to try a little online dialogue with a distant, more-advanced colleague, dealing with materials already in the community data base. Also, if a new stage of service is available in this *community way*, a large number of people will benefit from the lower threshold of investment and determination needed to give it a try. 3a2

Following is a brief description of community-Workshop applications that special communities can consider exploring. The sequence represents an explicit progression, beginning with tested techniques whose *cultural shock* and financial investment are relatively low, and offering paced, open-ended evolution with time, experience, and perceived payoff. We are arranging for computer support of these services by a commercial-quality *utility* service connected to the ARPANET. We will provide this Workshop support (at cost) over the Network to selected subscribers for setting up and exploring prototype, augmented-Workshop applications. We expect the Workshop toolkit to be continually expanding and improving, and plan for much of the evolutionary energy and direction to come from the subscribers. 3b

COLLABORATIVE DIALOGUE: We offer computer aids for the composition of messages and for their subsequent reviewing, cross-referencing, modification, transmission, storage, indexing, and full-text retrieving. A *message* may be one word in length, or a hundred printed pages. In any message there may be formalized citations pointing to specific passages in prior messages, so that a group of related messages becomes a network of recorded-dialogue contributions. There is also: automatic delivery of messages; full cataloging and indexing; online accessibility both to message notification and to the full text of all messages; and open-ended storage of the dialogue records. These services enable a community of people who are distributed in space and time to maintain recorded, collaborative dialogue at a new degree of effectiveness. 4

Then to support *real-time* remote dialogue (teleconferencing), we have the following facility: Any two DNLS users can *link up* at any time, so that each party sees a common display view, including both his and the other person's cursor; either party is able to point or control, and they mutually have access to the full range of Workshop functions, over any of the online information. The responsiveness and bandwidth of the ARPANET provide remarkably good support of our highly interactive DNLS service to remote display users, so that when used to supplement a telephone conversation, the speed and flexibility of this shared, *augmented blackboard* brings a new quality to teleconferencing that is really quite dramatic. 4a

DOCUMENT DEVELOPMENT, PRODUCTION, AND CONTROL: We offer a rich set of computer aids for the composition, study, and modification of document drafts, and for automatically generating high-quality photocomposition output with flexible controls for font-designation and formatting, to enable the production of publication-grade hardcopy (printing masters, or microform masters). There are processes for collaboration between several writers, and with an editor, in the process of evolving a final draft. Included among such helpers can be experienced production people to help in laying out a finished document, in inserting proper designations for specifying font, size, and density of different character strings, and for managing footnotes, cross-references, tables of contents, indices, etc. There are also aids for the people who must keep control of changes, new-version distributions, etc., and provide the indexing to complex documents or sets of documents. Planned improvements include facility for handling complex graphic portrayals and extensive special symbols. 5

RESEARCH INTELLIGENCE: The provisions within the Dialogue Support System for cataloguing and indexing internally generated items also support the management of externally generated items -- bibliography, contact reports, clippings, notes, etc. With these centrally supplied (therefore uniformly available)

services, a community can maintain a dynamic and highly useful *intelligence* data base to help it keep up to date on external happenings that particularly affect it. Microform distribution can provide for mass replication of this data base at remote sites, and computer-generated indexes or online retrieval can facilitate access. Citations of external items from within the internally-generated dialogue base -- in the form of annotations, miscellaneous commentary, or supportive references -- offer computer-sensible interlinking of the external information with the internal, and considerably facilitate browsing, retrieval, back-citation searching, etc. 6

The Community could choose to operate a special Information Analysis and Integration Center as a nucleus to this activity, but the notes and private-collection records of individual users, integrated into the *recorded dialogue*, could well add the more value. (Reference 4 describes some developments and possibilities for support of research intelligence.) 6a

COMMUNITY HANDBOOK DEVELOPMENT: We are extending the above services toward the coordinated handling of a very large and complex body of documentation and its associated external references. I use the term *superdocument* to refer to such material when integrated into a monolithic whole. There are a number of important applications for a system that facilitates the responsive development and evolution of a superdocument by many (distributed) individuals. In particular, for either a discipline- or project-oriented community, one very important application of a centrally available *superdocumentation* service would be to maintain *The Community Handbook* -- i.e., a uniform, complete, consistent, up-to-date integration of the special knowledge representing the current status of the Community. 7

The Handbook would include: principles, working hypotheses, practices, special-term glossaries, standards, goals, goal status, supportive arguments, techniques, observations, how-to-do-it items, etc. An active community would be constantly involved in dialogue bearing upon the contents of the last formal version of its Handbook -- comments, errata, suggestions, challenges, counter examples, altered designs, improved arguments, new experimental techniqes and data, etc. Constant updating would provide a *certified, community position structure* about which the real evolutionary work would swarm; flexible aids for online *navigation and view generation* would be very important, as would the facility for automatic publication (especially into microform editions). 7a

COMPUTER-BASED INSTRUCTION: If relatively widespread applicability of Computer-Based Instruction (CBI) were suitable for the Community, then there would likely be advantage gained from pooling resources and utilizing a community-coordinated instructional service. For a community also utilizing other centrally managed Workshop services of the scope and power described here, there would be considerable overlap between them and their CBI processes and activities. 8

Even though CBI has more visibility and momentum as a discipline than does CBKW (Computer-Based Knowledge Workshop), it seems inevitable that the former will end up as being but a special, integrated component of the latter. One should expect CBI service anyway in his Workshop, and he won't expect to go to a different terminal or to learn a different set of interactive concepts and skills to get that service; and also, that service will often bear directly upon concepts and matters deeply embedded in the workaday domain of his Workshop system. 8a

It is also very probable (to my mind) that communities will ultimately integrate their Handbook and CBI techniques so that their monolithic, superdocument Handbook would contain the special tags, links and etc. required by the CBI computer processes so that a significant portion of the instructional services would be generated directly from the primary knowledge source, the Community Handbook. 8b

MEETINGS AND CONFERENCES: This refers to assemblies of people, which occurrences aren't likely for a long time yet to be supplanted in total effect by technological aids. In supporting our own ARC meetings, demonstrations, etc., we use TV-projector equipment that projects our regular work-terminal display images onto a movie screen, easily readable in a meeting room having enough ambient light for comfortably reading notes and seeing each other. Images from live TV-cameras or from video recorders can also be projected. We make use of commercial devices for controlling these various video signals -- switching, mixing, and frame-splitting. We can mix two signals to get image superposition, or split the video frame to get a computer-display picture on one part of the screen and a camera image on the other (for example, simultaneously showing the camera view of the user's controlling actions right along with the display responses from the computer). 9

With this projector setup, we use our regular Workshop techniques in meetings to present and explain material from the online data base. It is easy to review and change the agenda and the meeting notes; some meetings operate very profitably in a mode of *collaborative position-statement development*, with a facility that for many purposes is far superior to using a blackboard -- it is as though the blackboard now is very easily stretched to make room for new notes, edited, scrolled, folded, reorganized, or etc., and any available online material may be copied onto it

for integration into the study, re-organization, re-wording, development process. A skilled Workshop user can operate this *blackboard* with enough speed and flexibility that these processes often don't seem to be what limits group progress (in the midst of questions, deliberations, etc.). 9a

Any Workshop user at the gathering can call on part of his own online notes, or use his familiarity with certain material, to bring special information before the assembly. Or, the whole assembly can see the display being controlled by another individual (or assembly) at a remote site, in shared-display dialogue. There are many further technical and procedural innovations to explore in improving the effectiveness of meetings -- e.g. computer-processed bio-feedback, radical changes in the *rules of order*, and giving each participant independent use of a private display terminal. 9b

COMMUNITY MANAGEMENT AND ORGANIZATION: Where the Community has conventional, project-management operations, their Workshop can include computer aids for such as PERT and CPM, plus the enriching services of dialogue support, document development, and a *Handbook* system. An extension of the Handbook could contain plans, commitments, schedules, specifications, current-state records of work in progress, etc., with special Workshop tools to support management analysis and control. 10

But also, with the probable increase in the amount and intensity of distributed collaboration within the Community, *committee work* would become more widespread, dynamic, and important. Thus there would be greater dependence upon better techniques for inter-communication and management within the committee-like structures by which a Community goes about its composite business. Harnessing these new techniques will lead to very different ways in which distributed communities can be organized and in which they can go about their business -- and the possibility of considerable improvement here, stemming from relatively modest innovative investments, is an important part of our motivation toward facilitating Community Workshop exploration. 10a

SPECIAL KNOWLEDGE WORK BY INDIVIDUALS AND TEAMS: Assumedly, Community members could avail themselves of the above types of Workshop service in support of their own daily work -- i.e., for other than their participating in community-oriented activities. There are obvious benefits to almost any knowledge worker from use of general Workshop facilities such as listed above; and for a team (or any close-working organizational unit) of augmented knowledge workers, there is yet another level of benefit to be gained by adopting new organizational structure and collaborative methods that harness better the new capabilities existing within the Workshop (as extended by a few special team-support tools). 11

Then further, the particular set of disciplines and pursuits which characterize the Community will generally have special computer-based processes and data that are important in its work -- i.e. unique functions and forms in its analytical programs, statistical processes, numerical data, conceptual/analytic models, graphic portrayals of subject matter, etc. Assuming that they are available within the same computer network that distributes the Community's Workshop-support services, then access to these special computer-based resources can be provided to a worker *through* the coordinated Workshop in which he does his other work -- and to a distinct advantage. 11a

In any of this special work, there is basic advantage in having a flexible, powerful facility for managing mixed text and graphics -- composing, studying, modifying, integrating new material into working notes and reports, publishing, doing collaborative dialogue, giving presentations, etc. When doing tasks of this sort in assocation with his special computer-based operations, it is an important advantage to the worker to do so within a familiar and consistent working environment. Our Workshop flexibly provides for special translation of information passing back and forth to any such *external* computer service, so that for access to a wide variety of such services the Workshop can provide users with consistent conventions and methods in whose use his other Workshop tools would be of maximum support. 11b

CONCLUSION

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The full sense of what computer networks offer in the way of *resource sharing* contains some special twists of significance here: For one thing, a truly complete Workshop will contain a very large repertoire of service functions, and the evolution, operation, and maintenance of these functions (and their support software) will require highly trained specialists. Any sort of widespread exploration of augmented-Workshop techniques will be very much facilitated by the network's capability for sharing the expertise of such specialists -- by enabling central computational resources that they develop and maintain to service distributed users. Note that specialists working from their home Workshop will be able to reach through the network to install and maintain software in remote hardware installations, which will be important, too; but note also that many already-present local computers and operating systems are inappropriate for supporting all of the important Workshop functions. 12a

For another thing, the vocabulary and procedural skill required to harness these functions effectively and smoothly into one's worklife will become very extensive and sophisticated (the pidgin-English approach won't provide the power, and full-statement natural language isn't fast enough), and again special expertise will be necessary to help people through the learning stages as their Workshop matures. Therefore, although the network can very much facilitate bringing into user reach these powerful Workshop tools, it requires the additional network-supported (Workshop) facilities such as teleconferencing to enable a limited number of Workshop specialists to give close support to these learning processes, without which the computer services would have much less value. 12b

If exploration of Workshop use were to occur only where there exists both an appropriate local computer system and trained specialists to maintain the software and train the users, there would be a very much slower evolution toward the increased-effectiveness possibilities offered by computer augmentation. 12c

Finally, the *digital-packet transportation system* aspect of a computer network seems quite essential to the practical, effective support of an augmented Community Knowledge Workshop -- which in turn seems to offer a really important and unique means for sharing among a community of humans the distributed nuclei of human resources represented by individuals with special knowledge, judgement, intuition, imagination, conceptual skills, etc. This human-resource sharing has explosive potential -- I look to it with a biological metaphor as providing a new evolutionary stage for the nervous system of social organisms, from which much more highly developed institutional forms may evolve that are much improved in: awareness of self and environment, situational cognizance and response, visualization of the future, problem-solving capability, etc. (See Reference 5 for expansion of this theme.) 12d

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